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ABSTRACT

Women computer science students at the College of Staten Island (CSI) in New York have a substantially higher pass rate than their male classmates; however, their enrollment and retention rates are low. During the last year and a half women on the computer science faculty at CSI developed two projects designed to increase the enrollment and retention rates of female undergraduate computer science students. Some outcomes of these projects include: a brochure profiling the female computer science faculty and outlines benefits of a career in computer science; a series of review workshops on material in the introductory computer science course; two seminars for potential women majors in which the department was introduced and career opportunities were discussed; a multi-user database which collects background information from the seminar participants; and a mentoring program which provides alumna role models. The faculty are also trying to encourage women to pursue graduate degrees in computer science. Women undergraduates are being actively recruited to participate in research projects. Three tables depict the enrollment in an introductory computer course by gender for 1988-1990; computer science majors by gender for 1990-1992; and a summary of response analysis from a computer science alumni questionnaire. (Contains 13 references.) (Author/AEF)

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Paper (W2-201B)

Encouraging Enrollment and Retention of Women in Computer Science Classes

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Abstract

Women computer science students at The College of Staten Island (CSI) have a substantially higher pass rate than their male classmates; however their enrollment and retention rates are disappointingly low. Eighteen months ago we initiated a project to improve this situation. We are in the process of assembling our procedures in a kit form so that they may be easily disseminated to groups planning similar programs.

Background

While many reasons have been proposed as to why there are relatively few women in the computer science field, no one denies that there is a problem. Women make up 45% of the American work force, yet only 30% of all computer scientists are female [PP90].

The percentages in academic computer science are even lower. The 1990-91 Taulbee Survey [GM91] shows that of all the Ph.D.'s awarded in computer science in 1990, only 13% were received by women. For fourteen consecutive years, starting in 1979, women accounted for only 10-14% of Ph.D.'s. Moreover, many of these women did not pursue academic careers. Of the 137 computer science departments surveyed, only 8% of the faculty are female.

Professor Joseph O'Rourke, of Smith College, describes the decline of the participation of women in Computer Science and Computer Engineering (CS&E) throughout the length of the academic "pipeline" from high school through the professorial ranks, as follows: "Although roughly equal numbers of young women and men take computer science courses in high school, women receive about 31% of the bachelor and 28% of the masters degrees, and about 11% of the Ph.D.'s in CS&E. After a new bump to 13% at the assistant professor level, the decline continues, with the Taulbee survey data showing associate and full professor percentages in CS&E to be 8% and 4% in 1992." [OR93]

Various reasons have been proposed to explain this declining participation of women in computer science. Foremost among them is the observation of a pervasive low self esteem among young women [L90,A92]. One possible cause is the lack of positive role models at every level of schooling. Those who have succeeded, have consistently attributed their progress to their parents' and teachers' encouragement. A recent article in the New York Times describes three very successful computer scientists. "While the three women differ in many ways, they share at least one thing besides smarts: Each was bolstered early on by family and teachers who instilled in them a sense that they could do anything." [H93]. Professor O'Leary of the Computer Science Department of the University of Maryland states in a biographical sketch that her parents had high school educations, yet, "Education was a top priority in my home and my father encouraged both of his daughters to earn advanced degrees in science." She continues, "..a very dedicated teacher of mathematics got me interested in a computer project for a science fair. Her confidence in me and the doors she opened, enabled me to enter Purdue University as a mathematics major."[OL93]

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In addition, many women have a perception that computer science has no social relevance. Essie Lev, a counselor in the department of Information and Computer Science at the University of California at Irvine (UCI) states, "One of the reasons we are losing students in general, and women and minorities in particular, is that we have lost a sense of passion and a sense of social relevance about what we do." [C93] Paul Young of the University of Washington comments, "Historically, women (and perhaps to a lesser extent minorities) have sought out fields, such as biology and the social sciences, that emphasize social relevance and teamwork. By emphasizing those areas of computer science and computer engineering that most require those qualities, it may be possible to attract more women (and minorities) to computing professions."

In an article for the Computing Research Association, Professor Nancy Leveson discusses the Illinois Valedictorian Project where 80 high school valedictorians in Illinois were tracked through their graduation from college. Although the women did slighdy better than the men, their self-esteem went steadily down while the men's self-rating remained essentially constant. Professor Leveson reports that this project found that "the most successful antidote to women dropping out of the pipeline after a bachelor's degree was the opportunity of female undergraduates to have some successful professional experiences in terms of participating in independent research with a professor, professional employment, opportunity for interaction with graduate students and support and encouragement by a faculty mentor."[L90]

Professor C. Diane Martin of the department of Electrical Engineering and Computer Science of George Washington University chaired a research workshop entitled, "In Search of Gender-Free Paradigms for Computer Science Education." The recommendations from the workshop included: "The group recommended counteracting these obstacles with an immediate national effort at the middle-school level to develop programs appealing to girls because that is the age they lose interest in math, science and computers. ... The focus at this level should not be on programming but on the relevance of the computer to social needs ... [using] cooperative learning environments." The group charged with examining the retention issue recommended "targeting high school, college and graduate science programs. They recommended structured labs using group projects based on cooperative learning models; formal peer, faculty and alumni mentoring program for women and minority students; pairing of college students with high-school students and pairing graduate students with college students to provide positive peer role models."[M90].

Our college

The College of Staten Island is a medium-sized public institution (enrollment about 12,000) which is one of 21 colleges of the City University of New York (CUNY). This past fall, CSI moved to a new, 200-acre campus in Staten Island. Our new computer science laboratories are fully equipped with state-of-the-art computing facilities. CUNY is a commuter university which enrolls over 200,000 students. Because of its urban location and its low tuition, CSI, and CUNY, have a higher proportion of female students than most public institutions (CUNY-wide, over 60% of the student body is female). Many of the women are adults returning to school while, or after, raising families. Approximately 80% of the student body at the college are first generation college students. Staten Island is the smallest borough of New York City, with a population of slightly over 400,000. It is primarily a working class borough whose female graduates do not generally pursue careers in science. About half of the graduates of Staten Island high schools who go on to college choose to attend the College of Staten Island.

Our project

During the last year and a half women on the computer science faculty at CSI have developed two projects which were designed to increase the enrollment and retention of undergraduate women in computer science classes at the College of Staten Island. The projects, entitled "Encouraging the enrollment and retention of women in computer science courses" and "Fostering an alumnae/undergraduate relationship: a retention plan for women computer science majors," received modest funding by the City University of New York (CUNY) Women's Research and Development Fund. The projects were motivated by data which showed that while the number of our women undergraduates taking computer science classes was disproportionately low, their pass rates in prerequisite and major courses were substantially higher than that of their more numerous male classmates (see Table 1). We were particularly concerned that, while the women were doing well in their coursework, their percentage in our computer science program has been dropping (see Table 2).

Year	Males	Females	% Females	%Men Passed	%Women Passed
1988	219	100	31	51	56
1989	227	79	25	62	73
1990	189	79	29	60	72

Table 1. Enrollment in Introductory Computer Science Course (CSC 126) by gender

Semester	Number of Students	Number of Women	Percent Women
Fall 1990	115	29	25.2
Spring 1991	119	26	21.8
Fall 1991	109	19	17.4
Spring 1992	111	18	16.2

Table 2. Computer Science majors by gender

The computer science faculty at our campus has a large representation of women (one third of the full-time faculty). Three have taught here since the early days of the department (16, 20, and 21 years). One has chaired the department and two have been deputy chairpersons.

In addition to our faculty, our population of computer science graduates includes many females who are well-placed in industry, and who still live close to our campus. Both of the projects capitalized on our unusually rich resource of female role models in order to encourage undergraduate women to enroll in and complete courses leading to a major in computer science.

Some outcomes of these projects include:

- A brochure profiling the female computer science faculty and outlining some of the benefits of a career in computer science for women.
- A series of review workshops on material in the introductory computer science course, conducted by upper level undergraduate women. Evaluations from the participants indicated approval of the workshops and requests for additional workshops.
- Two seminars for potential women majors in which the department was introduced and career opportunities were discussed. At each, a different alumna of our program who is currently working as a computer scientist spoke about her career.
- A multi-user database which collects background information from the seminar participants. It was developed by two undergraduate women majors as part of this project. Software was also developed by the undergraduate women to tabulate results and to display a statistical analysis of the data.
- An "adopt an undergraduate" mentoring program for women which provides alumna role models. Its purpose is to encourage students to complete their major and provides contacts for possible graduate school or employment opportunities. Some results from an alumni survey performed prior to this project are shown in Table 3 below.
- A report detailing our recruitment and retention program will be produced this Fall. It will include information on the various seminars and workshops which we conducted.

Question	Female Percent Yes	Male Percent Yes
Employed after graduating?	100	96
Have continued studies?	80	82
Salary over $40,000?	60	52
Less than six months to find job?	90	82
CSI prepared student for job?	86	68

Table 3. Summary of Response Analysis from Computer Science Alumni Questionnaire (Numbers provided by the Office of Institutional Research. Survey prepared by Professor Moroh)

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Current Projects

In addition to the projects described above to increase the number of undergraduate women majors in computer science, the women faculty are trying to encourage women to pursue graduate degrees in computer science. We are actively recruiting our women undergraduates to participate in research projects.

The women undergraduate students will work with the four women faculty members, all of whom are involved in research. Their research projects include topics in Multimedia Instruction, Expert Systems, Databases and Scientific Data Management, Algorithm Animation, and Computer Modeling.

The research projects will use a variety of computer platforms and software. In addition to the new computer laboratories, some of our faculty, including one the authors of this paper (Moroh) have received an NSF grant to set up a multimedia laboratory for undergraduate instruction in science, engineering and mathematics. The new facility will contain $200,000 worth of equipment which will be available for these projects.

In conjunction with the multimedia laboratory, we are working on four projects led by department chairperson, Professor Michael Kress. We expect these projects will appeal to those students who wish to combine computer science with the socially relevant goal of helping disabled individuals. Informal surveys have indicated great interest in these socially responsible projects among women students. The projects include:

- A three-year program to develop a calculus course for blind students using computer based multisensory assistive technology with auditory and tactile presentation of text and graphics. A grant proposal submitted jointly with the Computer Center for the Visually Impaired of Baruch College (CUNY), has been approved for funding by the NSF.

- A project to develop an American Sign Language (ASL) multimedia dictionary and tutorial station. It will be used by the Resource Center for the Deaf at the College of Staten Island. The station will enable a person to see the ASL sign for an English phrase, sentence, or word.

- A multimedia project to teach language skills to primary school age children with hearing disabilities using animated cartoons. Cartoons will be captioned in English with a window showing an interpreter signing in ASL. This project is a joint effort of teachers working with hearing impaired children in Staten Island public schools, members of the Computer Science department at CSI and the Resource Center for Deaf and Hard of Hearing Students (RCDHH) of CSI. The pilot program will be installed at P.S. 31 in Staten Island.

- A project to develop multimedia computer programs for testing and evaluation of severely disabled children are being developed in conjunction with the Board of Education and P.S. 37 on Staten Island. Computer Aided Instruction (CAI) tutorial courseware is being written as well.

Once the research projects are completed, we plan to display them at a computer exposition where all potential computer science students will be invited. Our hope is that the participating students and their peers will be inspired by the projects and the presentations and that they will consider pursuing advanced degrees in computer science.

Since the inception of our computer science program over 20 years ago, first and second level computer science courses have incorporated closed labs with the professor present to clarify and reinforce topics taught in the lecture portion of the course. Each course meets for 6 hours per week: 3 hours in the lecture room, 3 hours in the laboratory. The same instructor teaches both lecture and laboratory. Closed labs are thought to be particularly effective for teaching and have been recommended in the 1991 ACM computing curricula [A91,HA93]. Over the years, we have tried various alternative models for the lower-level courses, including one in which a different professor teaches the laboratory, and one in which there is a single large lecture section and multiple small laboratory sections. Both approaches compared unfavorably to the unified lecture-laboratory approach.

For the past three semesters female members of our faculty have been teaching at least one section of every lower-level course in the computer science major, in the hope that women will be less intimidated about enrolling in the course. We have also begun teaching experimental sections of the first few computer science courses where some innovative teaching techniques are explored, such as the use of group projects based on cooperative learning models.

Conclusion

We expect that our programs will be instituted in colleges in the New York area (specifically, our sister institutions at the City University of New York, many of whom have expressed interest in our program). We are in the process of adapting our program to the high school level, in cooperation with Staten Island Technical High School, a science and technology high

school in our neighborhood. We hope ultimately to expand it to additional schools throughout the borough of Staten Island, and, ultimately to schools nationwide.

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